(*Chelydra serpentina*) from North America, a Leopard Tortoise (*Testudo pardalis*) from South America, two Argentine Tortoises (*Testudo argentina*) from the Argentine Republic, deposited; a Gold Pheasant (*Thaumalea picta*, ♂) from China, two Little Bitterns (*Ardetta minuta*), European, purchased; a Burrhel Wild Sheep (*Ovis burrhel*), born in the Gardens.

OUR ASTRONOMICAL COLUMN

COMET BORRELLY-BROOKS (1900 *b*).—The following elements and ephemeris are furnished by Herr J. Möller in the *Astronomische Nachrichten* (Bd. 153, No. 3654).

Elements.

T = 1900 Aug. 3·298 Berlin Mean Time.

$\omega = 12^\circ\ 30'\cdot2$
$\Omega = 328\ \ 1\cdot8$ } 1900·0
$i = 62\ 35\cdot6$
$\log q = 0\cdot00636$

Ephemeris for 12h. Berlin Mean Time.

1900.	R.A. h. m. s.	Decl.	Br.
Aug. 16 ...	3 50 8 ...	+75 55·7 ...	0·63
17 ...	4 0 12 ...	77 36·3 ...	60
18 ..	4 12 37 ...	79 10·3 ...	56
19 ...	4 28 4 ...	80 37·7 ...	53
20 ..	4 47 52 ...	81 57·7 ...	50
21 ...	5 13 26 ...	83 9·5 ...	48
22 ...	5 47 9 ...	84 11·4 ...	45
23 ...	6 31 8 ...	85 0·8 ...	42
24 ...	7 26 5 ..	85 34·6 ...	40
25 ...	8 28 54 ...	+85 49·3 ...	0·38

EPHEMERIS FOR OBSERVATIONS OF EROS.—The following is a continuation of co-ordinates computed by Herr F. Ristenpart (*Astronomische Nachrichten*, Bd. 152, No. 3643).

Ephemeris for 12h. Berlin Mean Time.

1900.	R.A. h. m. s.	Decl.
Aug. 16 ...	2 0 29·40 ...	+27° 56′ 22″·5
18 ...	3 19·51 ...	28 38 11·6
20 ...	6 6·71 ...	29 20 17·4
22 ...	8 50·73 ...	30 2 40·0
24 ...	11 31·33 ...	30 45 19·5
26 ...	14 8·25 ...	31 28 16·1
28 ...	16 41·22 ...	32 11 29·5
30 ...	2 19 10·01 ...	32 54 59·5

THE ASTROGRAPHIC CHART CONFERENCE.—The fourth meeting of the International Committee for directing the photographic delineation of the sky has recently been held in Paris, commencing July 19. The first matter taken in hand was the appointment of a sub-committee of nine astronomers to draw up a scheme for the systematic observation of Eros during the coming opposition, for determinations of solar parallax. The reports from the co-operating observatories show that in fifteen of them the work is being vigorously pushed forward; unfortunately, in the remaining three, Rio de Janeiro, La Plata and Santiago (Chili), the work has entirely fallen through.

Dr. Thome, of the Cordoba Observatory, has been enabled, by the generosity of the Argentine Government, to volunteer for the work assigned to La Plata (−24° to −31°), and M. Enrique Legrand stated that he had induced his Government to found an observatory near Monte Video (Uruguay) to carry out the zone (−17° to −23°) allotted to Santiago. It was also suggested that the new observatory at Perth, West Australia, might possibly carry out the work on the remaining zone (−32° to −40°).

Another important item of the discussion was the advisability of publishing the rectangular co-ordinates of the stars as measured, with, of course, the constants of each plate, or delaying the work until these could be transferred to equatorial co-ordinates. It was considered that in the near future the absolute positions of the comparison stars would be much more accurately known than at present. The only drawback to this scheme is that Dr. Scheiner, of Potsdam, has already started the publication of the catalogue giving R.A. and Decl. of the stars.

In connection with the assignation of photographic magnitudes, it appeared to be generally believed that the estimation of diameters by means of a scale is a surer plan than measurement with a micrometer for this particular branch of work, but no definite ruling was given on this point.

The original plan agreed to in 1896 for taking the chart plates with three exposures of 30m. each has not been followed at all the observatories, and it was resolved at this meeting that in future the method of taking the chart plates shall be decided by the individual directors. In the reproduction of these chart plates, it is unlikely that uniformity will be secured; the French observatories have made enlarged copies by heliogravure, but as each observatory would have to expend some 10,000*l.* to do this, the actual method of reproduction is left unsettled.

DETERMINATION OF SOLAR PARALLAX.—A circular has been issued by the special committee appointed by the International Astrophotographic Conference held recently at Paris containing the resolutions passed for systematising the work to be done at all the world's observatories during the coming autumn and winter, when it is hoped, by means of observations of the minor planet Eros, to determine the parallax and distance of the sun with a degree of accuracy previously unattainable. The following is a summary of the suggestions adopted:—

(1) That the determination of parallax of Eros be made by micrometric, heliometric and photometric measurements. (*a*) By observations of the planet east and west of the meridian at the same observatory. (*b*) By the co-operation of the observatories of Europe and North America. (*c*) By the co-operation of the observatories of the northern and southern hemispheres.

(2) During the period of parallax observations the diurnal movement of Eros should be determined as accurately as possible by heliometer, micrometer and photography.

(3) (*a*) Observers determining the parallax in right ascension should make measures each night and morning, profiting by all favourable circumstances to operate with as large hour angles as possible. (*b*) Observers finding parallax by difference of declination in northern and southern hemispheres, should arrange that the mean instants of observation do not vary much from the meridian passage of the planet at the southern station.

(4) It is necessary that special series of photographs be taken of the region traversed by Eros, in order to furnish accurate determinations of the positions of comparison stars.

As the varying atmospheric conditions will play an exceedingly important part in the observations, particularly those away from the meridian, MM. André and Prosper Henry have been asked to prepare suggestions for eliminating these difficulties.

At the time of writing, the following observatories have signified their intention of helping with the scheme:—Algiers, Athens, Bamberg, Bordeaux, Cambridge (England), Cambridge (U.S.), Cape of Good Hope, Catania, Cordoba, Chicago (Verkes), Edinburgh, Greenwich, Heidelburg, Leyden, Leipzig, Lyons, Marseilles, Minneapolis (U.S.), Mount Hamilton (Lick), Nice, Potsdam, Rome, San Fernando, Strassburg, Tacuboya, Toulouse, Upsala, Vienna (Ottahring), Vienna (Währing), Washington.

THE DISTANCE TO WHICH THE FIRING OF HEAVY GUNS IS HEARD.

IN a discussion which took place in NATURE some time ago on the so-called "Barisâl Guns" and other mysterious sounds, Prof. Hughes suggested that it would be desirable to ascertain how far the firing of guns can be heard (vol. liii. p. 31). In connection with another subject, that of spurious earthquakes (see NATURE, vol. lx. pp. 139–141), I have for some time been collecting notes on this point, and I propose here to describe some of the facts obtained, chiefly with regard to the great naval review at Spithead on June 26, 1897, and the operations of the French fleet at Cherbourg on July 18, 1900.

I will mention first a few cases referring to more or less isolated observations of the reports of distant guns. The firing during the battle of Camperdown on October 11, 1797, is said to have been heard in Hull, the distance between the two places being more than 200 miles. A gentleman, formerly resident at Kertch in the Crimea, informs me that he has heard the sound of the guns fired at Sebastopol, distant 158 miles. During the American Civil War, the roar of the guns at the battles of Malvern Hill and Manassas (or Bull Run) was perceptible at

Lexington in Virginia, the distances being about 123 and 125 miles respectively (NATURE, vol. liii. p. 296). When the *Alabama* was sunk nine miles off Cherbourg on the morning of Sunday, June 19, 1864, the sound of the guns was heard in Jersey, at Clyst St. George, near Exeter (108 miles from Cherbourg), and at Brent Tor, near Bridgwater (about 125 miles). The great naval review at Spithead on July 17, 1867, was held during rough, boisterous weather; but the noise of the guns is said to have been heard at Exeter (105 miles), Morebath, near Tiverton (105 miles), Great Malvern (107 miles), and Castle Frome in Herefordshire (110 miles). In all the above cases the sound was, of course, the aggregate of that of many guns of different sizes fired simultaneously. But, in naval reviews, the charge is very much less than in actual warfare; a 6-inch gun, for instance, would fire a blank charge of 7 lbs., whereas the service charge for the same gun would be 48 lbs. fired with shot.

With regard to the distance to which the report of a single gun can be heard, I have very little information. A 110-ton gun fired at Woolwich made a window shake at Chignall St. James (24 miles), and was heard at Witham (32 miles) as a rumbling sound which seemed to deafen the observer slightly (NATURE, vol. xli. p. 369). Time-guns at Bombay have been often heard at the northern Mahim, distant more than 50 miles (vol. lvi. p. 223). The reports of the heavy guns at the battle of Malvern Hill, mentioned above, could be easily distinguished at Lexington from those of the smaller weapons; and a similar observation is recorded below. The subject is evidently one on which useful contributions to our knowledge might be made by residents near the south coast of England.

Naval Review at Spithead on June 26, 1897.

Shortly before the great naval review held in honour of the Queen's Diamond Jubilee, I wrote to the principal London newspapers and to several published in the south of England, and I have to thank the editors of these papers, and the ladies and gentlemen who replied to my inquiries, for the help they have kindly given me. The points to which I directed attention were the times at which the reports were heard, whether the air-vibrations were strong enough to make windows rattle, the direction from which the sound appeared to come, and the direction of the wind.

The fleet collected on this occasion consisted of 165 vessels of war of all classes arranged in five lines about six miles in length. The position of the flag-ship (H.M.S. *Renown*) was about two miles N. 20° E. of Ryde; and the distances given below are all measured from this point. As the Royal yacht entered the lines immediately after 2 p.m., the first shot was fired from the *Renown*, and was taken up by other ships in turn, each firing a Royal salute of twenty-one guns. "The heaviest gun employed," I am informed by the Secretary of the Admiralty, "was probably a 6-inch breech-loading gun, firing a blank charge of 7 lbs."; but others of different sizes were also used. It produced at first a dull crackling noise, according to a correspondent on H.M.S. *Sanspareil*, but, as ship after ship took up the salute, the firing grew more animated and the roll of the guns louder; until, after about five minutes, the report of the last gun died away.

The atmospheric conditions were fairly favourable for the propagation of the sound. Light, but variable breezes, generally between north-east and south-east, prevailed over most of the south of England. The thunderstorms which occurred on that day followed the salute in most places, but nearly all my correspondents (several being retired military officers) agreed that the sound of the guns could be readily distinguished from that of thunder.

In many of the records which I have received, the time is given so roughly that it is difficult to feel confident that they refer to the salute in question, and in several it is omitted altogether. Under the former heading come records from Honiton (90 miles from Spithead) and Shebbear, near Torrington (135 miles); and under the latter from near Rickmansworth (67 miles) and Great Malvern (107 miles). Excluding all such cases, the number of records is reduced to twenty, from nineteen places.

At very few of these places, and at none more distant than about 28 miles, were the vibrations strong enough to shake windows. Distinct reports were heard at the beginning and end of the salute as far as Farnham (34 miles), otherwise the sound was a dull, continuous roar, with occasional booms from the heavier guns. The sound was heard to the east as far as Framfield (57½ miles), to the north-east at Wimbledon (62 miles), to the north at Bloxham Green, near Banbury (88 miles), and to the west at Wellington in Somerset (93 miles). These are more or less isolated places, but there is a fairly continuous series of observations in a north-westerly direction, extending to Melksham (61 miles), Monkton Farleigh, near Bradford-on-Avon (67 miles), Bath (two observations, 69 miles), and Weston, near Bath (71 miles).

In the evening the fleet was illuminated, and a final Royal salute, similar to that at 2 p.m., was fired on the return of the Prince of Wales shortly after 11 p.m. I have only two accounts which may refer to this salute, one from Cosham in Hampshire at 11.30 p.m., the other from Ashburton in Devonshire (116 miles) at 11.59 p.m. The recorded times differ too widely to give much value to these observations.

Naval Review at Cherbourg on July 18, 1900.

About 10 p.m. a sham fight took place between two portions of the French fleet at Cherbourg in honour of the visit of the President, M. Loubet, to that town. The number of vessels engaged was forty-three, including thirteen of the largest and most modern battle-ships in the world. During the next few days accounts appeared in various English newspapers of a series of supposed earthquake-shocks felt shortly after 10 p.m. at different places along the southern coast, from Torquay to Bognor. The long duration of the disturbances and their apparent transmission through the air being opposed to a seismic origin, I wrote letters to a number of London and south-country papers, and the account which follows is chiefly based on the replies which I received to these letters.

As some doubt has been expressed with regard to the connection between the two phenomena, it may be well to mention the evidence in its favour. (1) With two exceptions, not one of the places (forty in number) from which records have come is more than a mile or two from the coast. There are several from the south of the Isle of Wight, but none from that part of Hampshire shielded from Cherbourg by the higher ground of the island. (2) Though a few persons in the open air assert that a tremor was felt, the great majority state that the sound travelled through the air and not through the ground; windows rattled loudly without there being any movement of the floor, and at Lancing (100 miles from Cherbourg) and Seaton in Devon (97 miles) observers placing their hands on the wall felt it distinctly vibrating; the noise caused a drumming in the ears at several places more than a hundred miles from Cherbourg. (3) The sounds were recognised as those of heavy guns by many persons, and with less hesitation the smaller the distance from Cherbourg. (4) The night was very still, hardly a breath of wind could be felt, and the sea perfectly calm; and the sound was heard to the east and west along the English coast at almost equal distances from Cherbourg. (5) Lastly, heavy guns are rarely, if ever, fired from English ships or forts at so late an hour; whereas more than 24,000 charges are said to have been fired in Cherbourg harbour during almost the same interval in which the sounds were heard in England.

Though the times of occurrence are roughly given, they agree for the most part in placing the commencement of the disturbances just after 10 p.m., and the end shortly before 10.30. Clearer evidence as to the identity of the sounds throughout the whole area affected is provided by the similarity in their relative duration and intensity. The first began about 10.2 or 10.3, and lasted nearly four minutes. Then came a pause of five minutes, when there was another burst of about the same intensity and nearly the same duration. About ten minutes later the third followed, slighter in intensity and of shorter duration, perceived almost as far as the others (at Torquay and Brighton, 101 and 104 miles respectively), though not by all observers.

I have no information as to the size of the guns used on this occasion, but they were probably much heavier than those employed for the salutes at Spithead in 1897. To the west, the sound was heard at Budleigh Salterton, Sidmouth and Torquay (101 miles from Cherbourg), Paignton (102 miles), and Dawlish and Exmouth (104 miles); to the east at Lancing (100 miles), Brighton (104 miles), and near Henfield (107 miles, and seven miles from the sea). At all of these places, and at many between, the air-vibrations were strong enough to make windows shake and rattle, and there are accounts of this or a similar effect being observed at a greater distance than the sound—at Plymouth (123 miles), and Menheniot, near Liskeard (136 miles, and five miles from the sea). At the latter place

the sudden rattling of a large window was distinctly heard at about 10 p.m., but it was unaccompanied by any sound. Judging from the intensity of the disturbances at Torquay and Brighton, I see no reason to doubt the connection of the latter observation with the firing at Cherbourg.

It is interesting to notice how the character of the sound changed with the increasing distance from Cherbourg. At St. Catherine's Point (65 miles) and Bonchurch (68 miles), both in the Isle of Wight, the sound was described as exactly like that of heavy guns. At Bournemouth and Muddiford in Hampshire (74 miles) there was a continual rumbling noise, with occasional heavier booms. At greater distances, as far as Lancing, Torquay and Paignton, the prominent reports ceased to be audible, and there was merely a deep monotonous throbbing noise, the pulsations recurring with great rapidity and regularity, resembling a very quick beating of a big drum far away, or the beats of the paddles of a distant and unseen steamer. At very great distances the vibrations (or some of them) do not seem to have attained the requisite strength to be audible to certain observers, one at Lancing (100 miles) referring to a most curious throbbing sensation in the air, and a dull sound like that of a distant train; while another at Brighton (104 miles) remarks that he heard or felt the sound. The rattling of the window and the inaudibility of the vibrations at Menheniot may perhaps be accounted for in this way. CHARLES DAVISON.

SUBJECTS FOR CONSIDERATION BY ELECTRICAL ENGINEERS.

THE current number (July) of the *Journal* of the Institution of Electrical Engineers contains a list of subjects suggested by the Council as suitable for papers to be read at the meetings or published in the *Journal*. The list is here reprinted, and it should be the means of directing attention to many important problems awaiting solution, as well as eliciting information upon the present position of various branches of electrical engineering.

1. Best methods of generating steam and steam power for variable loads.
2. Comparison of double- and triple-expansion engines for varying load conditions.
3. Automatic handling of fuel in power stations.
4. The present position and applicability of gas or oil engines for electrical power stations.
5. Description of plants for the utilisation of river- or tidal-power in the generation of electrical energy.
6. The present position and prospects of the application of liquid and of powdered fuel in electrical power stations.
7. The utilisation of blast-furnace gases or other waste products of manufactures in the generation of electricity.
8. The application of dust-destructors to the generation of electricity.
9. Electric light and power station chimney shafts; specialities of their construction and equipment.
10. Experiences with vibrations from electric light and power stations.
11. Bearings of shaft and shafting running at high speed.
12. Improvements in dynamos.
13. Comparison of speed and cost of dynamo.
14. Comparison of single and multiple central stations.
15. The wholesale supply of electricity to towns and factories from centres where very large generating units are employed.
16. The distribution of electrical energy from a distant generating station through districts served from a different source of supply, or under a separate local authority.
17. Electrical distribution by constant current, direct or alternating.
18. Examination of relative advantages and disadvantages of direct-current and alternate-current transmission.
19. Examination of relative advantages and disadvantages of two-phase and three-phase transmission.
20. Methods of controlling speed of alternating current motors.
21. Practical methods of measurement in connection with polyphase distribution.
22. Methods for the conversion of direct current into alternate current.
23. Methods of providing for electrical supply during hours of small demand.
24. Utilisation of lighting plant for other work during the hours of small demand.
25. The electrical equipment of large blocks of offices in a city.
26. Economy of design in the manufacture of small electric fittings.
27. Portable electric lamps of the "safety" type, or otherwise.
28. Enclosed arc lamps.
29. Improvements in incandescence electric lamps.
30. Incandescence electric lamps with filaments other than pure carbon.
31. Application of electrical transmission in factories:—
    (*a*) Detailed description, giving sizes of motors and power provided.
    (*b*) Comparison of separate or combined direct and alternate-current methods.
    (*c*) Combination of lighting and power for such purposes
32. Electricity meters.
33. Description of electrical methods, or comparison of these with other methods, of propelling vehicles.
34. The supply of electrical energy for tramway purposes.
35. The use of electrical methods of traction on railways served by steam-driven locomotives.
36. The economy and design of electrical elevators.
37. The design and economy of electrically driven pumps.
38. The utilisation of electrical energy in mining.
39. The applications of electrical energy in warfare.
40. The use of electricity in the textile and other industries.
41. The application of electricity in musical instruments.
42. Electro-therapeutics.
43. The establishment of public time-services by electricity.
44. Recent advances in telegraphy.
45. Applications of alternating currents in telegraphy.
46. The transmitting capacity and load factor of telegraph circuits.
47. Hertzian telegraphy.
48. Methods, in aërial telegraphy, of restricting signals to selected stations.
49. Recent improvements in telephony.
50. Descriptions of systems tending to simplify the interchange of telephonic communications.
51. The talking capacity and load factor of telephone circuits.
52. The application of electricity to the generation of heat for domestic purposes (cooking, ventilation, heating, &c.).
53. The construction and use of electric furnaces.
54. The application of electricity to the welding or annealing of metals.
55. The application of electrical heating methods in chemical or metallurgical operations.
56. The applications of electricity in metallurgical processes.
57. The applications of electrolysis in the smelting or refining of metals, or in the chemical industries.
58. The electrical equipment of chemical factories.
59. Improvements in primary batteries.
60. Examination of the present position of secondary batteries in electrical engineering.
61. The direct generation of electrical energy from fuel.
62. The economic employment of thermo-generators.
63. Improvements in the apparatus for producing, and in the applications of, kathode and Röntgen rays.
64. The relative suitability and efficiency of the different materials available for any of the requirements of electrical engineering.
65. The electric strength of di-electrics.
66. Recent advance in the manufacture or use of insulating materials.
67. New insulating materials.
68. Electrical applications of aluminium, sodium, &c.
69. The electrical uses of the rarer metals.
70. The treatment, testing, specifications, or uses of iron or steel, or of iron alloys, for magnetic purposes.
71. The manufacture of permanent magnets.
72. The relation of chemical composition and physical condition to the electrical or magnetic properties of substances, considered in its bearing upon electrical engineering practice.
73. High-resistance metals for instruments or resistance coils.
74. New resistance alloys.
75. The protection of laboratories and observatories against magnetic disturbances due to local causes.
76. Recent legislation in its relation to electrical undertakings.
77. The relations between electric lighting or power corporations and municipal authorities.